United States Department of Agriculture

Weather Bureau

Washington

BALLOON THEODOLITE SPECIFICATIONS - 1932

I These specifications describe a light-weight portable theodolite to be used for observing pilot balloons. The complete instrument is to consist of a theodolite in which the telescope axis is bent through 90° by a prism, a leveling head, tripod, carrying case and accessories as described below and is to weigh not more than 20 pounds, exclusive of tripod, carrying case and accessories. The following are made a part of these specifications, except where they conflict with the provisions below, in which case the provisions of these specifications shall govern:

(a) Drawing No. B-1180, Tentative Standards Specifications for Tripod Threads.

(b) Miscellaneous Publications, Bureau of Standards, No.CS24-30, "Standard Threads".

(c) Miscellaneous Publications, Bureau of Standards, No. CS25-30, "Special Threads".

Copies of (b) at 10 cents per copy and (c) at 15 cents per copy, can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C.

MATERIAL AND WORKMANSHIP

II The bronze and brass alloys used in the manufacture of the instrument shall be of such composition as has proved in practice fully suited for the purpose. The metals used for center parts shall be of suitable alloys such that the difference of the coefficients of expansion of the metals of adjoining parts and also the coefficient of friction shall be small. Castings shall be sound, clear, free from blowholes, porous places, checks, or any other defects which will affect the strength or appearance of the parts.

III The scales on the vertical and horizontal circles shall be marked on sterling silver.

IV The graduations on the micrometer drums shall be engraved on a surface which will not stain or tarnish with use.

V All material used in the construction of this apparatus and not specifically described herein shall be of such a nature or of such a composition as is recognized as complying entirely with the best applicable practice of manufacturers of meteorological or surveying instruments.

VI The workmanship shall be of the highest grade for instruments of this class.

DESIGN

VII The accompanying photographs illustrate the essential features of the design of the instruments desired. The designing of the mechanical details not specified herein is left to the bidder. The degree of excellence attained in such designing is a factor which will be considered in awarding contract.

INTERCHANGEABILITY

VIII So far as is practicable, parts shall be interchangeable with similar parts used on standard instruments manufactured by the bidder. The degree of interchangeability attained shall be evidenced by a list of such parts as are interchangeable with the designations of the standard instruments to which they apply. This list will accompany the bid.

THE TELESCOPE.

IX The telescope shall have its axis bent through 90 degrees by a prism, preferably of the constant deviation type. If the prism is not of the constant deviation type, convenient means must be provided for its adjustment. An internal focusing device, operated by a rack and pinion, shall be provided by which the telescope can be focused for any distance greater than 50 feet. The eyepiece shall be of the achromatic type and shall be focused by means of a spiral movement. The distance of the outer end of this eyepiece shall be not less than three inches from the nearest surface of the telescope support. The telescope shall be mounted so that the portion of the axis carrying the eyepiece is coincident with the horizontal axis about which the telescope rotates, and shall be balanced in such a way that it will remain [illegible] in any position in which it is placed with the worms disengaged. Front and rear hinged sights shall be attached to the telescope which will enable the observer to sight an object at any angle of elevation of at least 85 degrees. The sights shall be designed to permit folding them down on the telescope when they are not in use. The theodolite shall, in addition, be equipped with a set of sights which will furnish a line of sight not over 2 inches from the geometrical axis of the objective arm of the telescope. These sights are to be used when the high

angle sights are folded down and, hence, should be mounted on the upper surfaces of, and not over 3/4 inch from the hinged ends of the latter sights when in the recumbent position.

X The optical characteristics of the telescope shall be as follows:

Magnification (Tolerance, plus or minus 5 per cent)	20 diameters
Diameter of exit pupil equal to or greater than	2.0 millimeters
Field of view not less than	2 degrees.

XI The image shall be of first quality with respect to definition and freedom from aberration.

XII The telescope shall give an inverted image.

CIRCLES AND MICROMETERS

XIII The diameter of the horizontal circle, measured from edge of graduation to edge of graduation, shall be not less than 6 inches while that of the vertical circle, measured in the same way, shall be not less than 4 3/4 inches. Each circle shall be graduated in degrees, on a silver inlay, with every fifth and tenth graduation marked with a line longer than the intermediate marks. The tenth graduations shall be designated with Arabic numerals from ten (10) to three hundred fifty (350), the zero point to be marked with an arrow-head pointing to the edge of the scale. The Arabic numerals shall be at least 1/16 inche in height. The vertical circle shall be numbered counterclockwise and the scale on the lower circle shall be numbered clockwise.

XIV Tangent screws will be provided which engage in 360 gear teeth cut in the edge of each circle. The threads of the tangent screws and of the circles shall be of the flat crest type. These tangent screws not only provide a means of receiving a slow motion about either axis but are provided with micrometer heads reading to the nearest tenth degree without estimation. The diameter of the micrometer heads shall be not less than 3/4 inch. The micrometer screws and the fiducial marks against which the circles are read must be so positioned as to permit the operator to observe through the telescope and to make the readings with the minimum change of position. There shall be a clearance of at least 1/2 inch between the knurled heads operating the tangent screws and all surrounding parts. The knurled head by which the tangent screw actuating the horizontal circle is turned must be conveniently located for operation by the right hand of the observer while he is looking through the telescope and the sense of the thread of the worm must be such that when the

upper part of the head is turned from the observer the image of any stationary object as seen in the telescope shall move to the observer's left. The knurled head by which the tangent screw actuating the vertical circle is turned must be conveniently located for operation by the left hand of the observer while he is looking through the telescope and the sense of the thread of the worm must be such that the axis of the telescope changes its elevation in a counterclockwise direction, viewed from the eyepiece side of the instrument, when the micrometer drum is turned so that the upper portion of the drum moves from the observer.

XV The circles, gears, tangent screws and graduations must be of sufficient accuracy to permit any angle, in azimuth or elevation, to be read with an error not greater than two-tenths of the smallest subdivision, i.e., 0.02°. The above tolerance includes any variation arising from backlash.

XVI The tangent screws and gears will be enclosed as much as is practicable in order to protect them from dust. A means will be provided for the disengagement of either tangent screw to permit the rapid rotation of the telescope when desired. The mechanism for disengagement will be provided with a spring or other suitable device which will retain the tangent screw, automatically, in either the engaged or disengaged position with sufficient firmness to prevent accidental change of position. Disengagement of the tangent screw actuating the horizontal circle shall be accomplished by pulling the knurled head away from the instrument, while upward pressure upon the knurled head of the tangent screw actuating the vertical circle shall effect its disengagement.

XVII Two level vials shall be mounted at right angle on the plate which carries the telescope supports to enable the central axis of instrument to be plumbed. A shift of the bubble through one division of 2 millimeters shall correspond to a change of approximately 2 minutes in inclination. The levels will be provided with adjusting screws.

XVIII TELESCOPE SUPPORT

The telescope support shall be sufficiently high to permit the telescope to swing through the zenith and to a position 30 degrees below the horizontal on either side.

ILLUMINATION OF PARTS FOR TAKING OBSERVATIONS AT NIGHT.

XIX The reticule of the telescope may be etched on glass or may be formed of crossed "wires". Means shall be provided for their illumination to make them faintly visible against a dark sky. One or more lights shall also be mounted on the instrument by which all scales may be illuminated sufficiently to permit them to be read easily without any

additional source of light. The wiring from the different lamps shall be brought together and terminate in a socket attached to the base which shall permit the wires from the battery to be readily attached or removed. A conveniently located switch shall also be provided in order that the current from the battery may be used only as required. The voltage of the lamps will be chosen to permit the entire lighting system to be operated by three dry cells connected in series.

FINISH.

XX All exposed surfaces, except screwheads, scales bubbles, lacquered parts, etc., shall be finished with a dark enamel, smooth baked finish, which shall not flake or chip under ordinary conditions of usage.

TRIPOD.

XXI The tripod shall be strong, rigid, and the full length non-extension type. The tripod head shall be of hard bronze alloy and threaded in conformity with the standard 8 threads, as detailed in the accompanying drawing No. B-1180. The tripod bolts shall have wing nuts with left hand keeper screws. It shall be provided with a suitable cap of aluminum, and the customary strap and buckle. The tripod legs shall be of the one-piece "split leg" type, made from selected, well seasoned, sound, clear, straight-grained, second growth, white ash, or equal. The grain of the wood shall run parallel with the length of the legs. The legs shall be routed out to form, with no sharp edges. Each leg shall be provided with a steel shoe of one piece construction. The shoe shall be accurately fitted and firmly secured to the leg with the lower end of the leg well seated in the shoe. Each leg shall also be provided with a spur. The spur may be welded to the shoe or cast integral with it. The tripod shall be provided with a spring anchor, one end of which shall be fastened to the head of the tripod and the other end capable of being anchored to a ring, at a point directly beneath the point of fastening. It shall be of such a length and have such an adjustability of length that a steadying tension may be obtained at all probable heights of the instrument.

ACCESSORIES AND TOOLS.

XXII Each theodolite shall be provided with a screwdriver, a pin for adjusting capstan headed screws, a wrench for removing center nut, dust cap and sunshade.

CARRYING CASE.

XXIII Each theodolite shall be provided with a mahogany

carrying case, and shall have the number of the instrument accompanying it clearly marked on the outside, as well as on the movable shelf or shelves. The door shall be hinged and provided with a key. The keys of all cases shall be interchangeable.

LIST OF BALLOON THEODOLITE PARTS

WITH PRINCIPAL PARTS NAMED AND NUMBERED.

Nos.	Names
1.	Tripod head 3.5" X 8
2.	Tripod bolts .375" X 16
3.	Tripod legs
4.	Tripod anchoring attachment
5.	Tripod plate 3.5" X 8
6.	Leveling head
7.	Leveling screws (.375" X 32)
8.	Center Cap
9.	Center cap spring
10.	Center nut .375" X 32
11.	Inner center
12.	Outer center
13.	Clamp collar
14.	Lower clamp
15.	Lower clamp tangent screw .25" X 40
16.	Lower clamp spring, plunger, and cap
17.	Lower clamp screw .25" X 28
18.	Horizontal limb
19.	Horizontal limb index
20.	Upper plate
21.	Horizontal limb worm with drum and operating knob
22.	Horizontal limb worm cover
23.	Horizontal limb index cover plate with reflector
24.	Plate bubbles, 60 m/m long, 13 1/2 diameters, sensitiveness about 120 seconds.
25.	Standards
26.	Standard caps
27.	Telescope and axle
28.	Telescope eyepiece
29.	Telescope sunshade
30.	Telescope cap
31.	Telescope short focusing lens mount
32.	Telescope short focusing lens cap
33.	Folding sight
34.	Vertical circle
35.	Vertical circle index
36.	Vertical circle guard
37.	Vertical circle worm with drum and operating knob
38.	Crosswire and scale illumination unit
39.	Crosswire adjusting screws cover
40.	Combination screwdriver and center-key
41.	Screwdriver
42.	Packing box
43.	Packing board
44.	Packing ring 3.5" X 8